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Effect of nitrite, ammonia, and temperature on *P. monodon* larvae

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P. monodon larvae from the Hatchery or Wet Laboratory were stocked in 4- and 5-liter experimental containers, with filtered seawater brought to the desired levels of nitrite or ammonia by adding $NaNO_2$(AR) or NH_4Cl(AR) to the media. The desired temperature range was maintained using either immersible heaters or temperature-regulated water baths. The feed used at the zoea stage was *Skeletonema* or *Chaetoceros* (5 to 10x 10^3 cells/mL) with *Brachionus* added at the mysis stage.

Experiments were conducted at least in duplicates. Nitrite and ammonia concentrations (Tables 1 and 2) were considered tolerable if the survival rates were at least 60% of that of controls.

Table 1. Effect of temperature on the survival and growth of *P. monodon* larvae at a salinity range of 30 to 33 ppt, pH range of 8.28 to 8.31, nitrite concentration range of 0 to 2.8 ppm, ammonia concentration range of 0 to 0.33 ppm, at initial stage N_6.

Temperature range (°C)	Survival (%)	Survival Stage	Average Weight (g)
25.0 to 26.5	80	P_3	0.51
29.5 to 32.0	54	P_5	0.53

Table 2. Effect of temperature on the survival of *P. monodon* larvae at a salinity range of 28 to 34 ppt, pH range of 8.00 to 8.10, nitrite concentration range of 0 to 0.67 ppm, ammonia concentration range of 0-0.38 ppm, at initial stage Z_1.

Temperature range (°C)	Survival (%)	Survival Stage
24 to 27	73	P_2
29 to 32	84	P_4
32 to 34	78	P_4

Toxicity levels of nitrite were found to vary with the larval stage. The experiments started with zoea and mysis stages and survival rates were measured at the early postlarval stage. Mortality was high even prior to molting to the mysis stage at the concentration levels found toxic. Mysis stage larvae could withstand 10 ppm nitrite and 60% survival was obtained at about 15 ppm. Zoea stage were sensitive to 5 ppm nitrite and the tolerable level was lower, which appeared to be about 3 ppm (Fig. 1).

The larvae could tolerate ammonia up to about 10 ppm, however, the effect of ammonia was shown more clearly in the zoea stage (Fig. 2). Mortality rates for both mysis and postlarvae were about the same when exposure was started at the zoea stage. The toxicity level appeared to be about 11 to 12 ppm of ammonia. When mysis larvae were exposed to ammonia they were

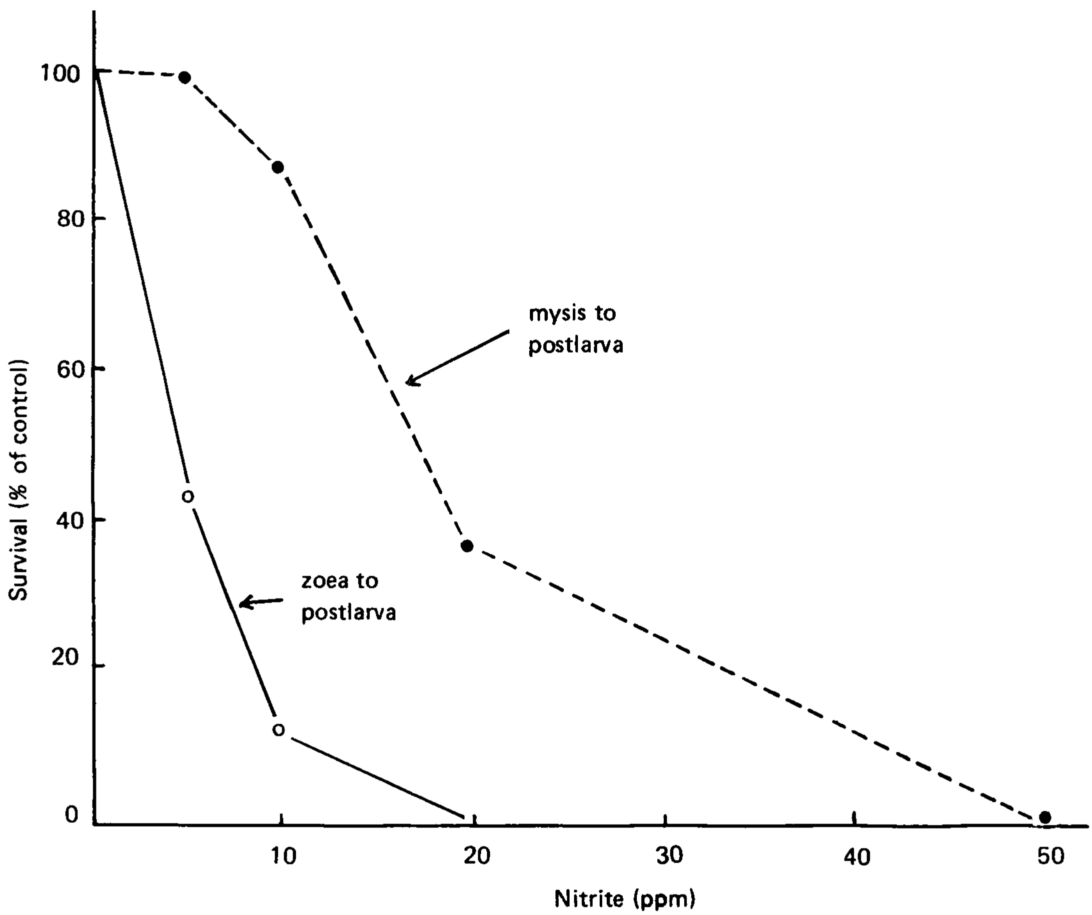

Fig. 1. Effect of nitrite on the survival of *P. monodon* larvae — zoea to postlarva, and mysis to postlarva.

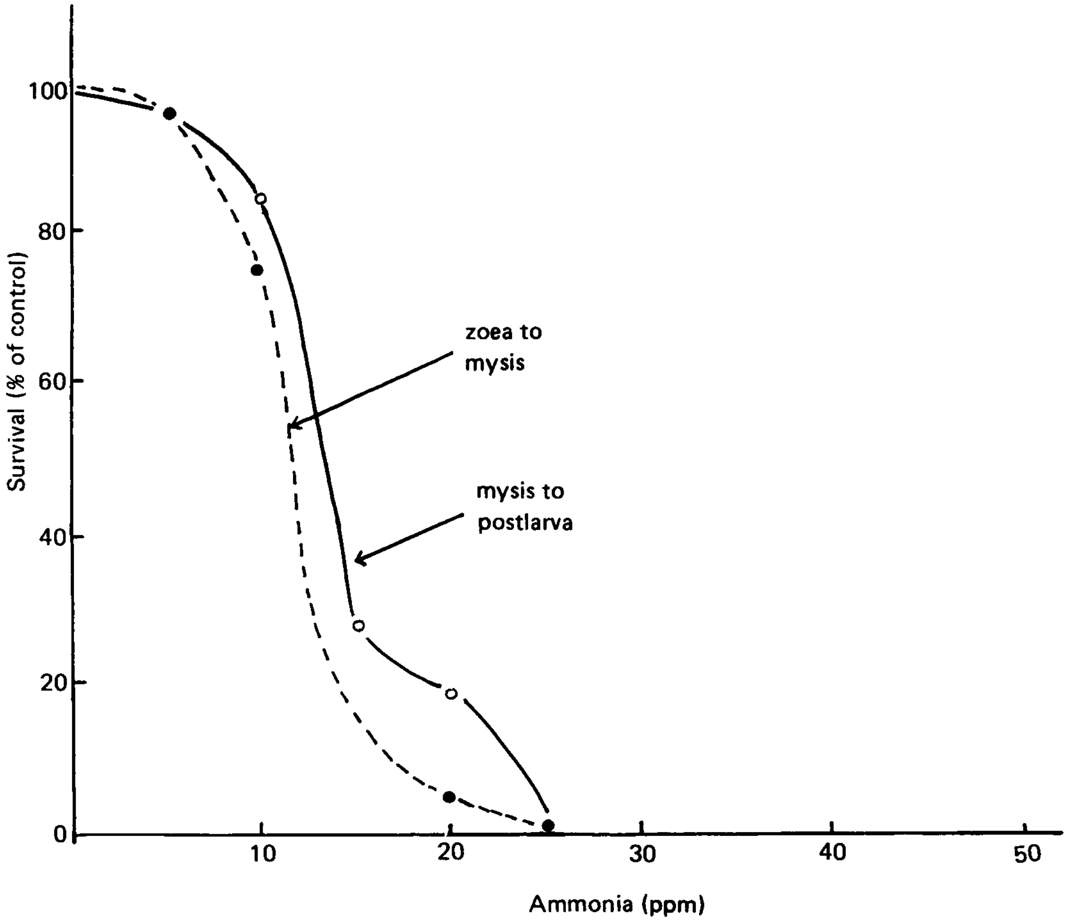

Fig. 2. Effect of ammonia on the survival of *P. monodon* postlarvae – zoea to mysis, and zoea to postlarva.

found to have higher tolerance levels. Survival of 60% was obtained even at 60 ppm of ammonia suggesting that the toxic effect of ammonia was greater in the zoea stage (Fig. 3).

Survival and growth were not significantly affected by temperature, however, molting was enhanced at temperatures higher than 29°C (Tables 1 and 2). Molting from zoea to mysis was not affected, while molting from mysis to postlarva was 2 days faster in aquaria with temperatures of 29 to 34°C.

These results showed that larvae of *P. monodon* have lower tolerance toward nitrite and ammonia compared with the postlarvae. Although high survival was obtained at low levels of nitrite and ammonia, it would still be necessary to know their effects on metabolism, that is, examine possible biochemical parameters to diagnose sublethal toxicity or stress.

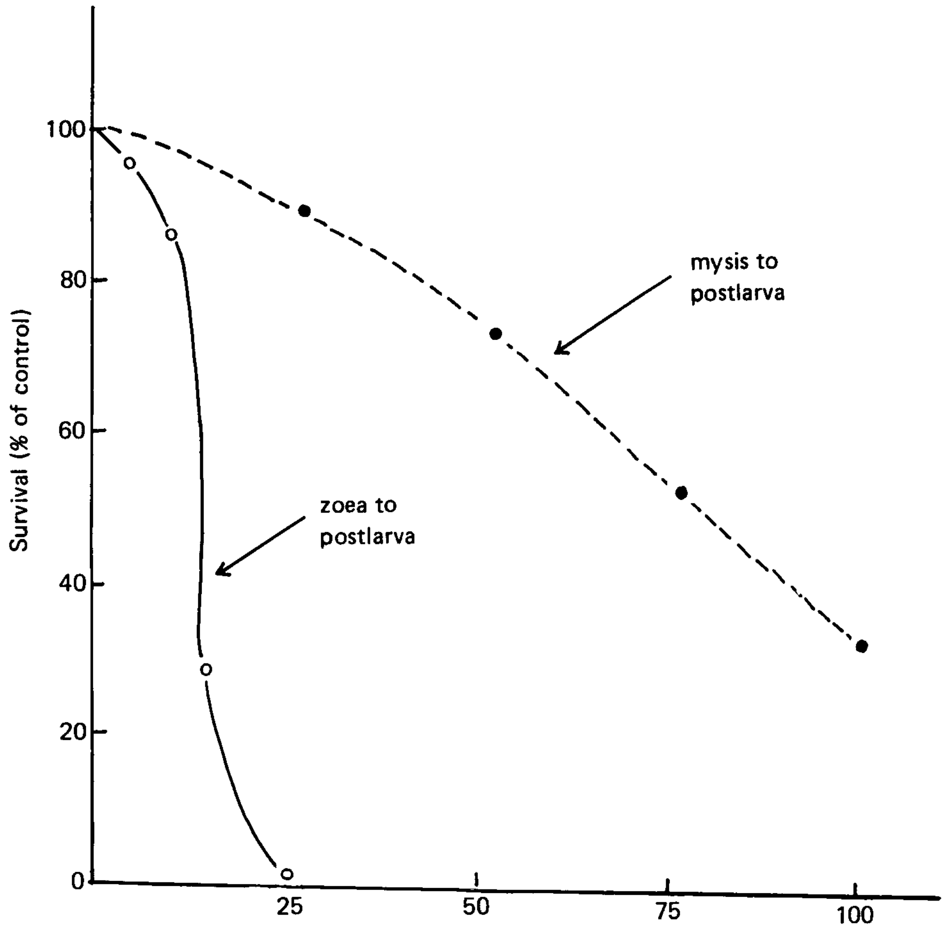

Fig. 3. Effect of ammonia on the survival of *P. monodon* larvae – zoea to mysis, and mysis to postlarva.